INSTRUCTIONS

PRESSURE BIAS LOAD CONTROL AND FUEL LIMITER GOVERNORS

GE 7FDL DIESEL ENGINES

DESCRIPTION

GENERAL

This bulletin describes one of several arrangements used in governors for controlling engine load and limiting fuel for turbocharged engines. This arrangement permits establishment of a derating curve which enables close matching of the system with the normal compressor characteristics while still derating sufficiently. In the extreme case of complete loss of the turbocharger, this arrangement permits continued running of the engine without exceeding exhaust temperature limitations. The system reduces engine load before limiting fuel.

LOAD CONTROL (Fig. 1)

The basic load control system adjusts the load on an engine as a function of governor speed setting and fuel. This

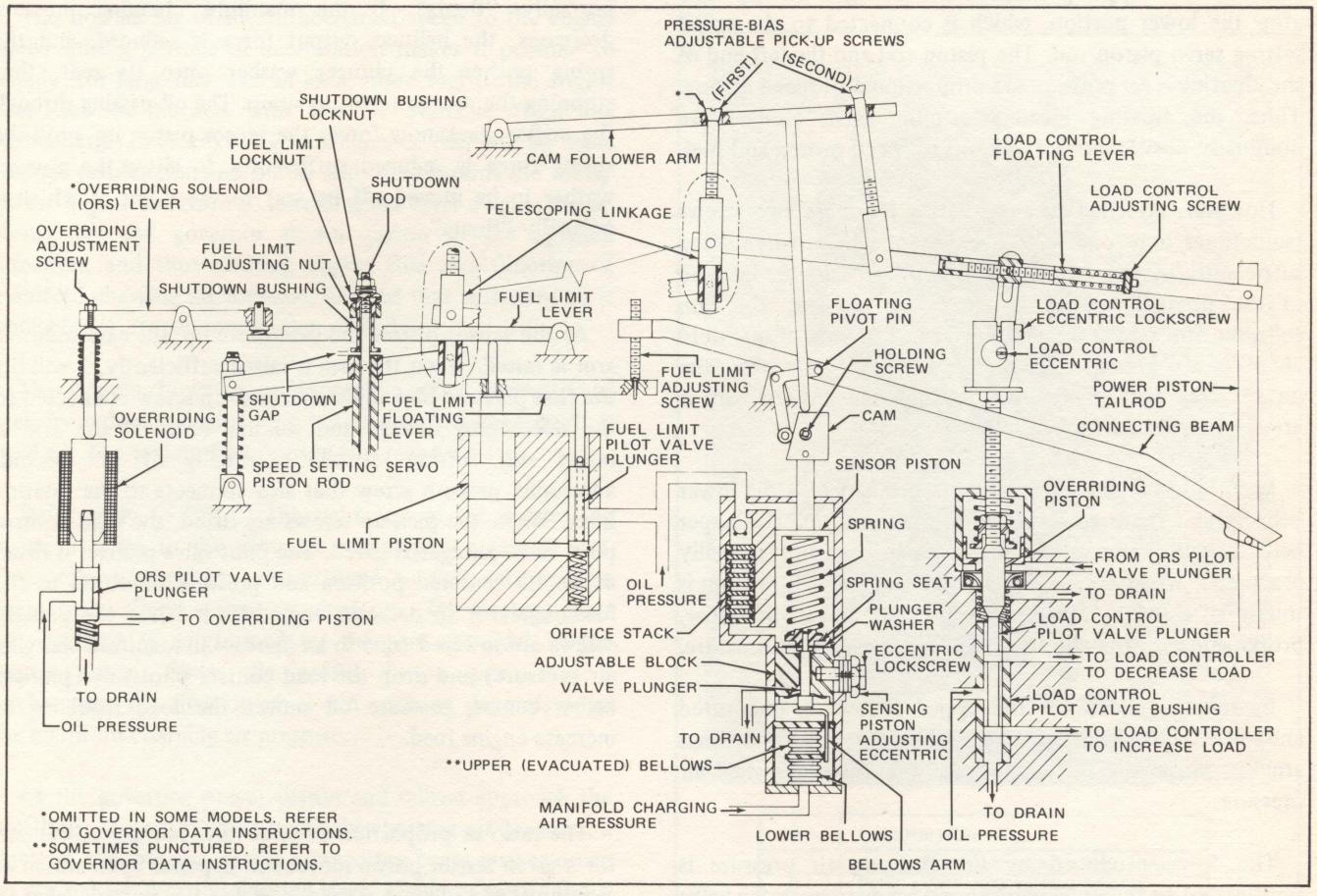

FIG. 1, E-15067A

FIG. 1. PRESSURE BIAS LOAD CONTROL AND FUEL LIMITER DIAGRAM.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

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arrangement schedules load as a function of governor speed setting, fuel setting, and the pressure of the manifold charging air.

The load control pilot valve plunger is suspended from the floating lever. When the pilot valve plunger is centered (its control lands exactly covering the control ports in the pilot valve bushing), no oil flows to or from the load regulator. If the pilot valve plunger is lifted above its centered position, pressure oil is directed to the load regulator to decrease engine load. If the pilot valve plunger is lowered below its centered position, pressure oil is directed to the load regulator to increase engine load.

One end of the floating lever is connected to the power piston tailrod. The tailrod position is proportional to fuel setting (engine load). The other end of the floating lever is attached to the upper portion of a telescoping linkage assembly. The upper portion of this linkage assembly rests atop the lower portion, which is connected to the speed setting servo piston rod. The piston rod and the left end of the floating lever position are proportional to speed setting. Thus, the floating lever and pilot valve plunger are nominally positioned as functions of speed setting and fuel.

However, attached to the floating lever are two screws (sometimes only one screw), either of which, when lifted sufficiently by the cam follower arm, can raise the left end of the floating lever and pilot valve plunger. The cam follower arm moves up and down as a function of manifold charging air pressure. The cam follower rests atop the output cam of the manifold pressure sensor. The cam is attached to the sensor piston.

Manifold charging air pressure is brought into the lower bellows and tends to push the bellows arm up. The upper bellows is the same size as the lower bellows and is usually evacuated. When evacuated, the force on the bellows arm is thus unaffected by atmospheric pressure and is, therefore, proportional to the absolute manifold charging air pressure.

In some applications, the upper bellows is punctured and, when this condition exists, the force on the bellows arm is proportional to the gage manifold charging air pressure.

The force produced by the charging air pressure is transmitted to the valve plunger and tends to push the valve plunger, plunger washer, and spring seat up. The spring between the sensor piston and spring seat tends to push the spring seat, plunger washer, and valve plunger down.

The unrestricted flow of pressure oil (from the governor pressure system) applies a constant force to the upper side of the sensor piston. A series of orifices restricts the flow of pressure oil to the underside of the sensor piston. Except while changes are occurring in the manifold pressure, the bellows force tending to push the valve plunger and plunger washer up is balanced or equalled by the spring force from the opposite direction. When the charging air pressure is constant, the plunger washer "floats" just off its seat in the adjustable block and continually bypasses to sump the oil passing through the orifice stack to the underside of the piston. This accounts for the continuous "bubbling" of oil from the top of the sensor when it is operating.

If the bellows force (from the charging air pressure) increases, the valve plunger and plunger washer are forced up, and oil flows out from under the sensor piston. The pressure oil above the piston forces the piston down, compressing the spring until the spring force is sufficient to move the plunger washer back to the point at which it normally "floats". If the manifold charging pressure decreases, the bellows output force is reduced, and the spring pushes the plunger washer onto its seat, thus stopping the escape of oil to sump. The oil passing through the orifice stack now forces the sensor piston up, until the spring force is reduced sufficiently to allow the plunger washer to be moved off its seat to the point at which it normally "floats".

As the sensor piston and cam move up, the cam follower arm is raised. When the arm is raised sufficiently, it will lift the first pressure-bias adjustable pick-up screw connected to the telescoping linkage and floating lever. If the arm is raised still further, it will eventually lift the second adjustable pick-up screw that also connects to the floating lever. When the pick-up screws are lifted, the load control pilot valve plunger is lifted. The pilot valve plunger is lifted above its centered position and pressure oil flows to the load regulator to decrease engine load. When the pick-up screws are lowered (due to an increase in manifold charging air pressure) and drop the load control pilot valve plunger below center, pressure oil moves the load regulator to increase engine load.

The ratio or proportion of pilot valve plunger movement for a given sensor piston movement depends upon which of the adjustable pick-up screws is lifting the floating lever. A typical two-slope derating curve, plotting fuel versus manifold charging air pressure at constant engine speed, is shown in Fig. 2. The curve shows graphically the effect of the two adjustable pick-up screws. Such a system acts to prevent excessive exhaust temperatures, by reducing the rack setting of the engine at load balance during periods of low turbocharger discharge.

FIG. 2, E-15068A

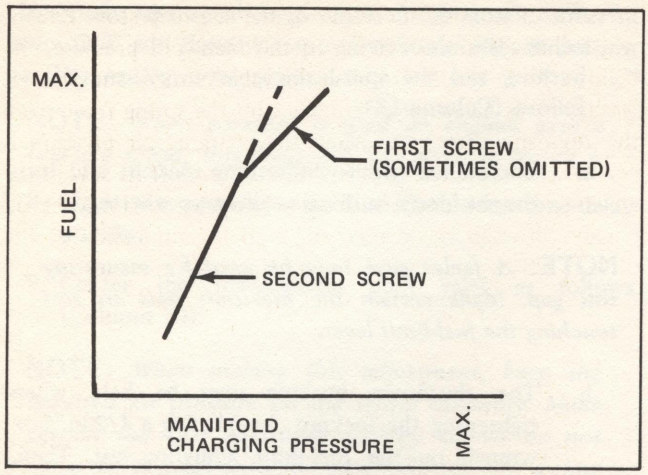


FIG. 2. TYPICAL TWO-SLOPE DERATING CURVE.

FUEL LIMITER

The normal lag of the turbocharger speed to the engine speed during periods of acceleration makes it possible to supply, for large increases in load, more fuel to the engine than can be burned with the air available from the turbocharger. The resulting imbalance of fuel and air leads to poor combustion and smoke and often retards the ability of the engine to return to normal speed after a load change. Restricting the governor power piston in the opening direction, and thus limiting engine fuel as a function of manifold charging air pressure, ensures that sufficient air is available for proper combustion of fuel.

This system, however, minimizes the actual restriction of fuel, by reducing engine load before the fuel limit point is reached. The system functions in this manner.

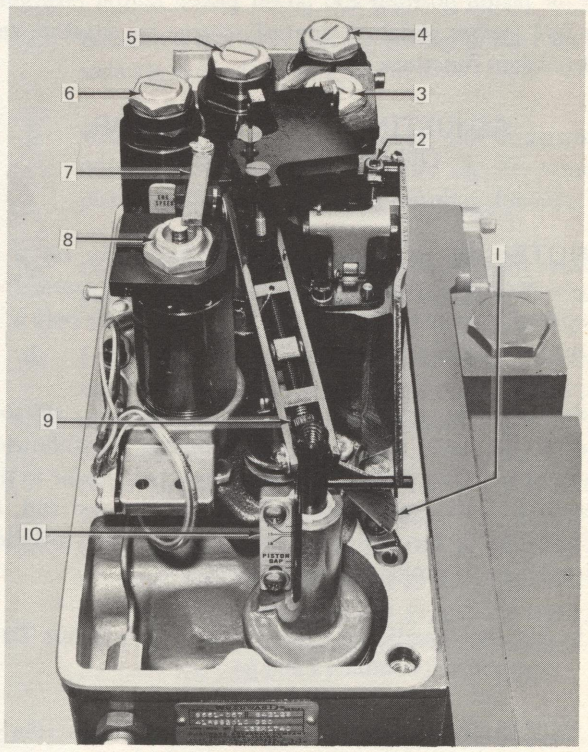
FIG. 3, E-16206

Refer again to Fig. 1. The right end of the connecting beam attaches to the governor power piston tailrod and, thus, takes a position proportional to fuel setting. The beam turns about a floating pivot pin. The floating pivot pin position is determined by the cam attached to the sensor piston. Since the profile for a given cam is unchanging, the floating pivot pin position depends upon the manifold charging air pressure.

As the governor power piston and tailrod approach the fuel limit for an existing manifold charging air pressure, a screw in the left end of the connecting beam pushes down on the right end of the floating lever. The lever pivots about the fuel limit piston and, in so doing, pushes the fuel limit pilot valve plunger below its centered position. The action directs pressure oil to the underside of the piston. As the piston is moved up, the floating lever now pivots about the screw in the end of the connecting beam. The spring under the plunger moves the plunger up as allowed by the floating lever.

The fuel limit piston also pushes the fuel limit lever up. As the limit lever moves up, the left end of the lever lifts the right of the overriding solenoid (ORS) lever. The ORS lever pivots and moves the left of the lever, overriding solenoid plunger and pilot valve plunger down. Pressure oil is thus directed to the overriding piston. The piston moves up, lifting the load control pilot valve plunger above center, thus moving the load regulator to decrease engine load.

NOTE: *Activation of the ORS lever produces a very fast unloading action (maximum time is 2.4 seconds) and is referred to as "fast (load) dump". Some models of governors, not equipped with an ORS lever, still get an unloading action, due to lifting of the pressure-bias screws by the cam follower arm, but it is at the normal load control timing rate.*



REF.	DESCRIPTION
1	LOAD-CONTROL INDICATOR SCALE
2	FUEL-LIMIT ADJUSTING SCREW
3	"C" SOLENOID
4	"A" SOLENOID
5	"D" SOLENOID
6	"B" SOLENOID
7	OVERRIDING-SOLENOID LEVER
8	OVERRIDING SOLENOID
9	LOAD-CONTROL ADJUSTING SCREW
10	POWER-PISTON GAP INDICATOR

FIG. 3. PG ENGINE CONTROL GOVERNOR, TOP FRONT VIEW.

The ORS lever action occurs before the fuel limit point is reached. If the governor power piston and tailrod position is such that the limit lever is caused to be moved a predetermined distance above the point at which load is reduced, the governor will act to limit fuel. The limiting action occurs when the limit lever contacts and raises the fuel limit nuts. The fuel limit nuts are threaded onto the shutdown bushing; the shutdown bushing is threaded onto the shutdown rod. The shutdown rod connects to the governor pilot valve plunger. Raising the governor pilot valve plunger to its centered position stops the governor power piston movement and limits fuel at that position of the power piston.

Thus, the governor power piston and tailrod can move up (and thereby increase fuel) only to the limit established by the position of the floating pivot pin, a position that is a function of manifold charging air pressure.

It should be noted that, though using common signals (sensor piston position and power piston tailrod position), the fuel limiter and load control scheme are separate and independent functions.

ADJUSTING THE GOVERNOR ON A TEST STAND (Fig. 1)

NOTE: *All adjustments should be made on a governor test stand, with the governor at normal operating temperature (140 F/60 C), and using only a recommended governor oil.*

Remove the governor cover and install a suitable oil-retaining dam. It is recommended that the following checks and settings be made in the order given. Refer to the Governor Data publication* for specifications and to GEI-81978 for recommended procedures (if not included below) for performing the following checks.

1. Set the speeds per GEI-81978 and Governor Data instruction (Columns 7 and 8).

NOTE: *When setting speeds, make certain the fuel-limit adjusting nut is not touching the fuel-limit lever and the shutdown bushing is not touching the speed-setting servo piston rod.*

2. Set the overriding solenoid (ORS).

3. With the governor running at the correct idle speed, adjust the shutdown gap (between the shutdown bushing and the speed-setting servo piston rod) as follows (Column 18):

   a. Loosen the shutdown-bushing locknut and turn the shutdown bushing to the proper setting.

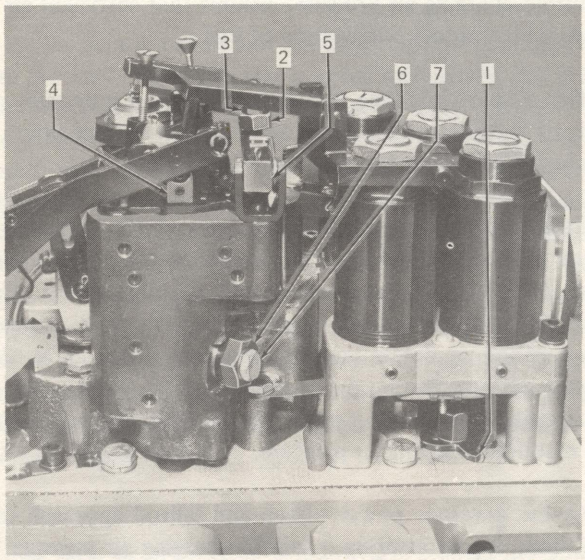
NOTE: *A feeler gage may be used for measuring this gap. Make certain the fuel-limit nuts are not touching the fuel-limit lever.*

   b. The shutdown bushing may be held when tightening the locknut, by placing a 1/2-in. box wrench on the fuel-limit adjusting nut. Then, tighten the shutdown-bushing locknut. The fuel-limit locknut should be tight against the fuel-limit adjusting nut before tightening the shutdown-bushing locknut. After adjusting, make sure the governor shuts down.

4. Set the speed-setting piston stop screw (Column 17).

5. Check the low-water shutdown (Column 9).

6. Check the low-oil shutdown (Column 9).



REF.	DESCRIPTION
1	SHUTDOWN TIME DELAY ADJUSTMENT
2	FUEL LIMIT ADJUSTING NUT
3	FUEL LIMIT LOCKNUT
4	FUEL LIMIT CAM
5	FUEL LIMIT LEVER
6	SENSING PISTON ADJUSTING ECCENTRIC
7	ECCENTRIC LOCKSCREW

FIG. 4, E-16207

FIG. 4. PG ENGINE CONTROL GOVERNOR, RIGHT VIEW.

*The column numbers which appear in this publication refer to the appropriate columns in the Governor Specifications Table in the Governor Data instruction.

7. Check the time delay. Time delay should occur in IDLE and Notch 1. See GEI-81978, Safety Shutdown Bypass Valve Adjustment.

NOTE: *When governor is used on engines with a low-idle speed, this delay will also occur in Notch 2.*

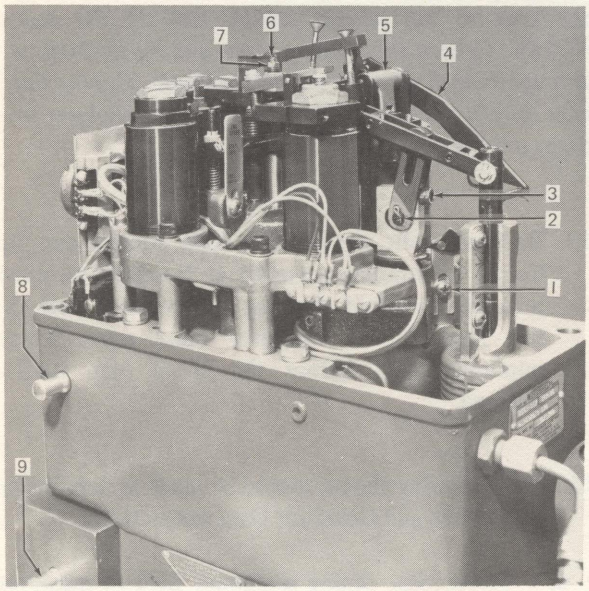
8. Mark the position of the shutdown time-delay pointer.

9. Center the load-control pilot valve as follows (Column 10):

NOTE: *When making this adjustment, keep the required air pressure on the sensor assembly. Make certain the two adjustable pick-up screws do not come in contact with the cam follower arm during this adjustment.*

a. With the specified air pressure, power piston gap, and speed setting, the load-control pointer should be at the maximum field start line.

b. With the specified air pressure, power piston gap, and speed setting, the load-control pointer should be at the zero line with the servomotor balanced.



REF.	DESCRIPTION
1	LOAD CONTROL POINTER ADJUSTMENT
2	LOAD CONTROL ECCENTRIC ADJUSTMENT
3	LOAD CONTROL ECCENTRIC LOCK SCREW
4	CONNECTING BEAM
5	FLOATING PIVOT
6	SHUTDOWN ROD
7	SHUTDOWN BUSHING LOCKNUT
8	LOW OIL SHUTDOWN BUTTON
9	LOW WATER SHUTDOWN BUTTON

FIG. 5, E-16208

FIG. 5. PG ENGINE CONTROL GOVERNOR, LEFT VIEW.

c. If Steps a and b are not within limits, check the load-control pointer setting. With the governor running as in Step a, loosen the load-control eccentric lockscrew, and adjust the load-control eccentric until the brush-arm indicator on the servomotor remains stationary at approximately 12 o'clock. Set the load-control pointer at the zero line.

d. With the pointer properly set, continue to adjust the eccentric and the adjusting screw until Steps a and b are within limits. Use the adjusting screw for half the distance required to achieve Steps a and b and the eccentric for the remaining distance.

10. Adjust the sensor piston to have the cam start its upward movement at the required inches of mercury air pressure as follows (see Column 20 for correct notch and pressure):

a. Position a dial indicator to the top of the cam to indicate vertical movement.

b. With the governor speed set at the designated notch, increase the air pressure on the sensor piston until the piston stops traveling downward.

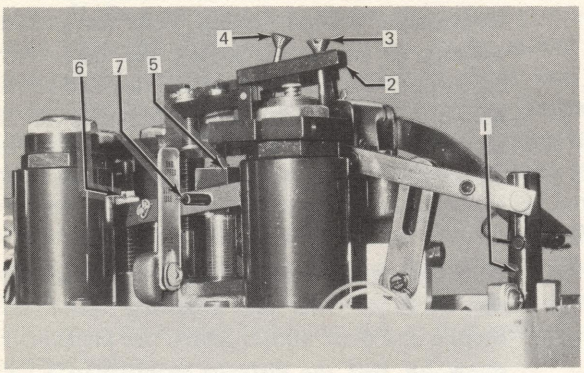
c. Adjust the dial indicator to zero, with the sensor piston at its extreme downward position.

d. Lower the air pressure until the sensor piston starts moving upward. The piston should start its upward movement at the pressure designated in the Table in the Governor Data instruction. If the piston starts its upward movement before or after the designated pressure, loosen the eccentric lockscrew just enough so that the sensing-piston adjusting eccentric can be set so the piston starts its upward movement at the proper air setting. With the adjustment made, tighten the lockscrew. Recheck the adjustment.

11. To set the pressure-bias feature, proceed as follows (Column 12):

a. Adjust the first pick-up screw with the governor at the required speed, power piston gap, and air pressure. Turn the first screw until it contacts the cam follower arm and the indicator on the servomotor brush arm just starts toward minimum field. The purpose of this adjustment is to have the screw set so a slight decrease in air pressure will cause the indicator to move to minimum field.

FIG. 6, E-16209A



REF.	DESCRIPTION
1	POWER PISTON TAILROD
2	CAM FOLLOWER ARM
3	SECOND PRESSURE-BIAS SCREW
4	FIRST PRESSURE-BIAS SCREW
5	SHUTDOWN GAP
6	BASE SPEED-SETTING NUT
7	SPEED-SETTING INDICATOR SCALE AND POINTER

FIG. 6. PG ENGINE CONTROL GOVERNOR, LEFT VIEW.

b. Adjust the second pick-up screw with the governor at the required speed, air pressure, and power piston gap. Turn the second screw until it just contacts the cam follower arm and the indicator on the servomotor starts toward minimum field. Reduce the air pressure, and the servomotor indicator should balance at the required power piston gap.

12. Adjust the fuel limiter to activate the overriding solenoid; then, with a reduction in power piston gap to pick up the shutdown rod and reduce fuel and speed to the engine, proceed as follows (Column 11):

a. Set up the first test condition given in the Governor Data instruction. Set the governor speed and apply air pressure to the sensing device.

b. Set the power piston gap.

NOTE: *A dial indicator (installed and zeroed at shutdown) may be used to read tailrod movement instead of power piston gap. See Columns 23, 24 and 25.*

c. Adjust the fuel limit adjusting nut so the fuel limit lever is horizontal just as the lever contacts the fuel limit adjusting nut.

d. Adjust the fuel-limit adjusting screw just to the point where the speed drops 10 rpm.

e. If the governor has an overriding solenoid lever, adjust the fuel limit adjusting screw so ORS is activated just before fuel limit (and speed reduction) occurs. This requires a 0.005-0.015 in. clearance between the fuel limit lever and the fuel limit adjusting nut to exist at the time ORS is activated.

f. Reduce the power piston gap and see that the shutdown rod rises, reducing fuel and speed.

g. Set up the second test condition. With the governor at the required speed and air pressure, decrease the power piston gap. At the required power piston gap the load control indicator should move toward "minimum field" and speed should be reduced.

NOTE: *If Step g is not within the limits prescribed, recheck Steps a through f, and readjust if necessary. If Step g is not within the prescribed limits and Steps a through f are found correct, loosen the screw holding the cam to the sensing piston, and tip the cam slightly. Tighten the holding screw and repeat Steps a through g until all steps are within limits. Tipping the cam toward the roller will make Step g occur closer to Steps a through f.*

13. Recheck both pressure-bias load control and fuel limiter by running governor at Notch 8 and slowly reducing manifold charging air pressure. Note that the load control indicator must move toward minimum field before the speed (and fuel) is reduced.

14. The following checks should be made as described in GEI-81978 and Governor Data instructions.

a. Servomotor timing minimum field to maximum field (Column 10)

b. Servomotor timing maximum field to minimum field (Column 10)

c. Servomotor timing maximum field to minimum field, ORS energized (Column 10)

d. Servomotor pressure with servomotor stationary (Column 10)

e. Potentiometer resistance (total) (Column 10)

f. Solenoid resistance (Column 16)

g. Time from Idle to Notch 8 speed (Column 14)

h. Time from Notch 8 to Idle speed (Column 15)

i. Check that the governor is free of oil leaks

j. Check that hunting and jiggling are not excessive.